MULTIMEDIA UNIVERSITY

STUDENT ID NO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 3, 2022/2023 (TERM ID 2230)**

## ERE1236 – ANALOG ELECTRONICS

( All sections / Groups )

3 OCTOBER 2023
9:00 am – 11:00 am
( 2 Hours )

---

**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of 8 pages with 4 questions only.
2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

## Question 1

a) State

i) **SIX** characteristics of an ideal op-amp. [6 marks]

ii) **TWO** fundamental rules in the analysis of an ideal op-amp as a result of the ideal characteristic assumptions. [2 marks]

b) i) Sketch an inverting amplifier. You must include an op-amp, $R_f$, $R_i$, $V_i$, $V_o$ and GROUND in the figure. [5 marks]

ii) Derive the mathematical expression of the output voltage, $A_{CL}$, $V_o$, in terms of the input voltages $V_i$, $R_f$ and $R_i$. [6 marks]

iii) A 0.2 V, 100 Hz sinusoidal waveform is applied to the input of the inverting amplifier. Sketch the output waveform with respect to the input and label all the important values on it. Assume a close loop gain of TWO. [6 marks]

**Continued ...**

## Question 2

a) Briefly explain the following terms in the context of an operational amplifier.

i) Differential-mode voltage gain. [2 marks]

ii) Common-mode voltage gain. [2 marks]

iii) Common-mode rejection ratio. [2 marks]

iv) Close-loop voltage gain. [2 marks]

b) The slew rate of the amplifier in Figure 2(b) is 0.5 V/μs.

i) Is this an inverting or a non-inverting amplifier? Give your reason. [2 marks]

ii) Calculate the maximum supported frequency and maximum peak input voltage when $R_L = 8$ kΩ. [4 marks]

iii) Explain what will happen to the output of the circuit if the input exceeds the slew rate of 0.5 V/μs. Use appropriate diagrams to illustrate your explanation. [6 marks]

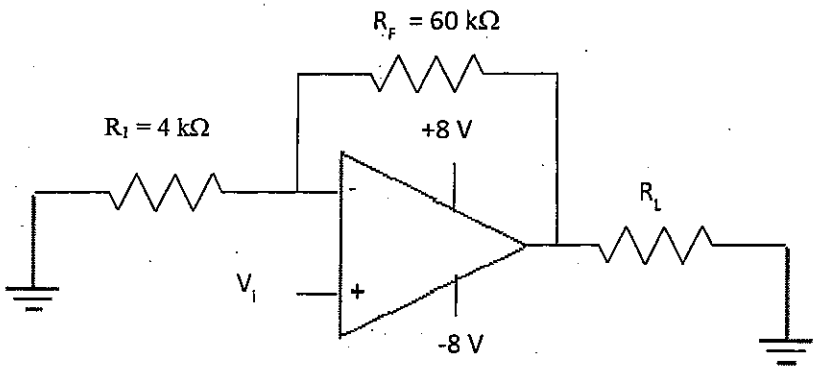


Figure 2 (b)

c) Power supply rejection ratio (PSRR) is a term widely used to describe the performance of operational amplifiers.

i) Define the meaning of PSRR. [2 marks]

ii) Calculate the output ripple voltage of an amplifier having PSRR of 200 dB and closed-loop gain of 140 dB for every 1 V ripple in its power supply voltage. [3 marks]

**Continued ...**

## Question 3

a) Voltage regulation plays an important role in applications that require a reliable predetermined DC voltage.

i) A simple zener regulator is shown in Figure 3(a)(i). Describe THREE disadvantages of this simple zener regulator. [6 marks]

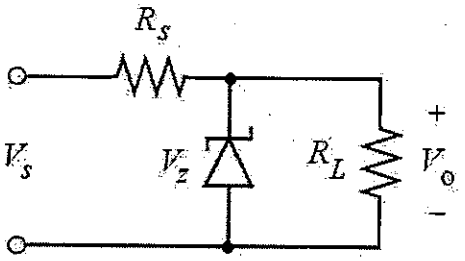


Figure 3(a)(i)

ii) The series voltage regulator is shown in Figure 3(a)(ii). The unregulated power supply may vary from 12 V (at full load) to 15 V (at no load). A power transistor with a maximum rating of 1.2 A is to be used as the pass transistor for an 8 V regulator. The minimum $h_{FE}$ of the transistor is 100. The required maximum load current is 800 mA. Determine the values of $R$ and the zener voltage, $V_Z$. ($V_{BE}$ = 0.7 V, zener operating current = 10 mA). [8 marks]

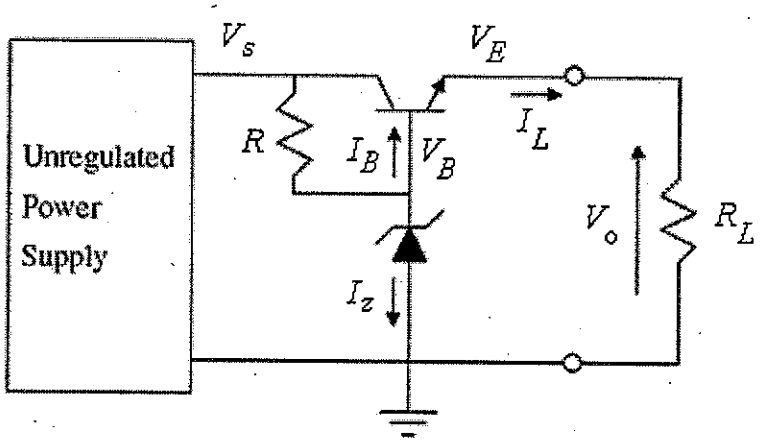


Figure 3(a)(ii)

**Continued ...**

b) Describe TWO conditions for an oscillator to sustain its oscillation. [4 marks]

c) The Colpitt oscillator circuit is shown in Figure 3(c). Assume that $R_1 >> \left|\frac{1}{\omega C_1}\right|$, where $\omega$ is the oscillation frequency.

i) Given that $L$ = 0.3 mH, $C_1$ = 0.6 μF and $C_2$ = 0.01 μF. Determine the oscillation frequency. [3 marks]

ii) Calculate the minimum amplifier gain and the value of $R_1$ in order for the oscillation to be sustained, given that $R_F$ = 60 kΩ. [4 marks]

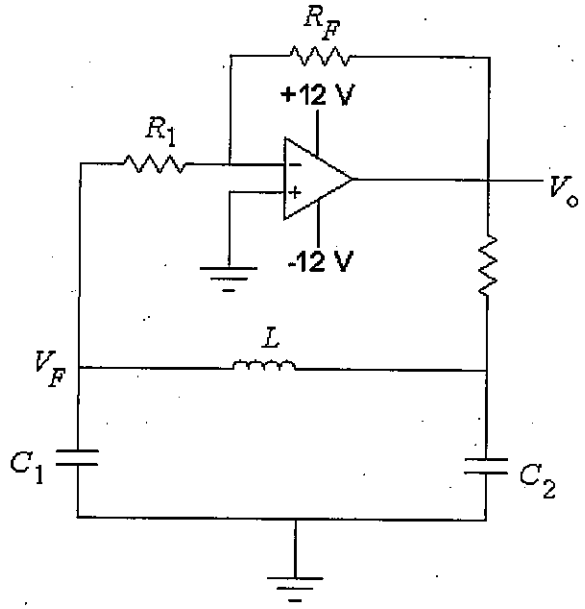


Figure 3(c)

**Question 4**

a) Active filters are used in almost all sophisticated electronic systems for communication and signal processing.

i) List down SIX advantages of active filters. [6 marks]

**Continued ...**

ii) A band-pass filter response is shown in Figure 4(a). Given that the filter has bandwidth, BW = 15 kHz and quality factor, Q = 5, calculate

I) $f_0$ [1 mark]

II) $f_L$ and $f_H$. [10 marks]

Show the working in **FULL**.

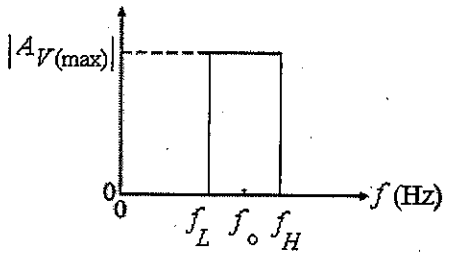


Figure 4(a)

b) A band-reject filter is shown in Figure 4(b). Design the band-reject filter so that it operates at $f_L$ = 2561.6 Hz, $f_H$ = 1561.6 Hz and $K_{PB}$ = 2. In your design, provide the values for C = 5 nF, C' = 10 nF, $R_F$ = 10 kΩ, $R_1$ = 10 kΩ, R, $R_1$', $R_F$', R', $R_2$, $R_3$, and $R_4$. [8 marks]

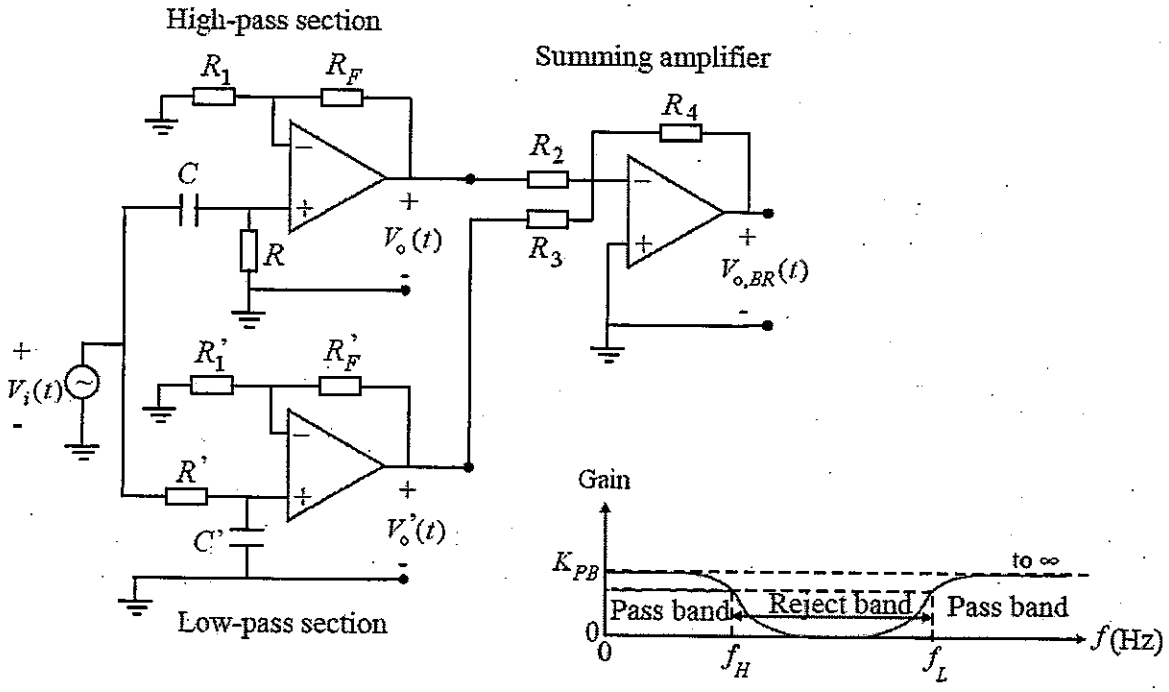


Figure 4(b)

**Continued ...**

c) The output waveform of a non-linear op-amp circuit is different from the input waveform. State TWO causes of non-linear operation in op-amp circuits.[2 marks]

**End of Paper**

## Appendix
## Formulae

$$K_{HP} = 1 + \frac{R_F}{R_i}$$

$$K_{LP} = 1 + \frac{R'_F}{R'_F}$$

$$f = \frac{1}{2\pi RC}$$

$$f_{max} = \frac{slew\,rate}{2\pi V_p}$$

$$PSRR(dB) = 20\,log\left\{\frac{\Delta V_{supply}}{\Delta V_{out}} \bullet A_v\right\}$$

$$C_T = \frac{C_1 C_2}{C_1 + C_2}$$

$$Q = \frac{f_o}{BW}$$

$$BW = f_H - f_L$$

$$f_o = \sqrt{f_H f_L}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$I_B \approx \frac{I_{L(max)}}{h_{FE}}$$

$$A = -\frac{C_1}{C_2}$$

**End of Appendix**